Original Research Article

ASSESSMENT OF EFFECT OF CEMENT DUST FROM CEMENT FACTORY ON ELEMENTAL PROPERTIES OF SOME CULTIVATED CROPS, OBAJANA, KOGI STATE, NIGERIA

Abstract

This study assessed the effects of cement dust pollution on cultivated crops in Obajana, Kogi state, Nigeria. Data was obtained from laboratory analysis of plant samples at Soil Science Laboratory, Faculty of Agriculure Ahmadu Bello University, Zaria, Kaduna state. Mean, standard deviation, coefficient of variability and T-test were used in analysing the data. The elemental properties of plants (maize and cassava) was altered as a result of cement dust pollution; for maize plant, Nitrogen decreased with increasing distance away from the factory, phosphorus increased with increasing distance from the factory while potassium decreased with distance away from the factory. The result showed that there was no significant difference in elemental properties in maize except for potassium which showed significant difference. In cassava plant nitrogen and phosphorus increased with increasing distance away from the factory and potassium decreased with increasing distance away from the factory and there was no significant difference for all the elemental composition in cassava plant.

Key words: ***Environmental pollution, cement dust, elemental properties, maize and cassava crop***

Introduction

Global attention is now focused on declining quality of the environment resulting from the rapid expansion in resources exploitation. There is an increasing need to use resources in a sustainable way, such that there is concurrent increase in production while also protecting the environment, biodiversity, and global climate systems. This type of compromise requires careful resource planning and decision-making at all levels (Nabwire, 2002). Nigeria's environment (at urban and rural levels) has suffered an accelerated decline in quality of air, soils, biodiversity and water resources (Abbas, 2009; Abbas, Muazu and Ukoje, 2010; Ujoh, Ifatimehin and Kwabe, 2011)

Environmental pollution generated from cement industry could be considered as an undesirable process that is responsible to pollute water, air and land through its various activities, right from the mining activity of the raw material (limestone, dolomite etc.) to its crushing, grinding and other associated processes in cement plant (Ramesh, Ahmed and Koperuncholan, 2014).

The production of cement has been increasing by about 3% annually (McCaffrey, 2002) and contribution of Portland cement production worldwide to the greenhouse gas emission is estimated to be about 7% of the total greenhouse gas emissions to the earth's atmosphere (Malhotra, 2002).This catastrophic effects of global warming are self-evident in melting of the polar ice, flooding, drought and changing flora and fauna of natural habitat for both plants and animals. In slightly over a century, both marine air temperatures and sea surface air temperatures have increased between 0.4°C and 0.8°C (Sheppard and Soochow, 2007).

The main environmental pollutants generated by the cement industries are dust and noise and these could cause dust laden air, cracking of walls of structures as well as soil, vegetation and water polluted by dust to an extent that farming may be unprofitable (Tijani, Ajobo, and Akinola, 2005).

The typical gaseous emissions into the air from cement manufacturing plants include nitrogen oxide (NOx), sulphur dioxide (SO_2), carbon oxides (CO and CO_2) and dust (Pregger and Friedrich, 2009; Kampa and Castanas, 2008). The dust escaping from cement factories is often transported by wind and deposited in areas close and far away from the factory. These include agricultural lands, natural vegetation, towns and villages, such depositions of particulate matter and other pollutants interfere with normal metabolic activities of plants, causing direct injury and impairment of growth and quality and may ultimately lead to decrease in plant yield (Ediagbonya *et al.*, 2013; Prajapati, 2012).

Among the anthropogenic activities that pose highest threat to the conservation of biodiversity and fragile ecosystems (thereby promoting environmental degradation) is mining of mineral resources, including limestone. Considering the observed environmental impact of the present Obajana cement plant, coupled with the expansion and projected plan of establishing a fifth production line in the same Obajana community, there is need to carry out an assessment of the extent of damage on some cultivated crops in the study area as a step in the direction of impact mitigation for the present facility; and prevention for future/proposed facilities.

The aim of the study is to assess the effect of cement dust on the elemental composition of cultivated crops (cassava and maize) in the study area.

Study area

Obajana lies between latitude 7°54'N and 7°56'N and longitude 6°24'E and 6°27'E in Kogi State (figure 1). It covers an area of approximately 686.81sqkm and has an undulating surface. Obajana is a small and very important community in Lokoja local government, Kogi state, north central Nigeria.

Obajana lies within the sub-humid tropical region and its climate are classified as tropical savanna with two main seasons (wet and dry seasons). Rainfall starts in April and ends in October and its mean annual rainfall ranges between 1100 and 1320mm, it is characterized by moisture laden southwesterly winds blowing from the Atlantic Ocean and dry season starts in November and ends in March with an average temperature of 26^{0}C almost consistent throughout the year and its characterized by northeast trade winds (SCPZ, 2015).

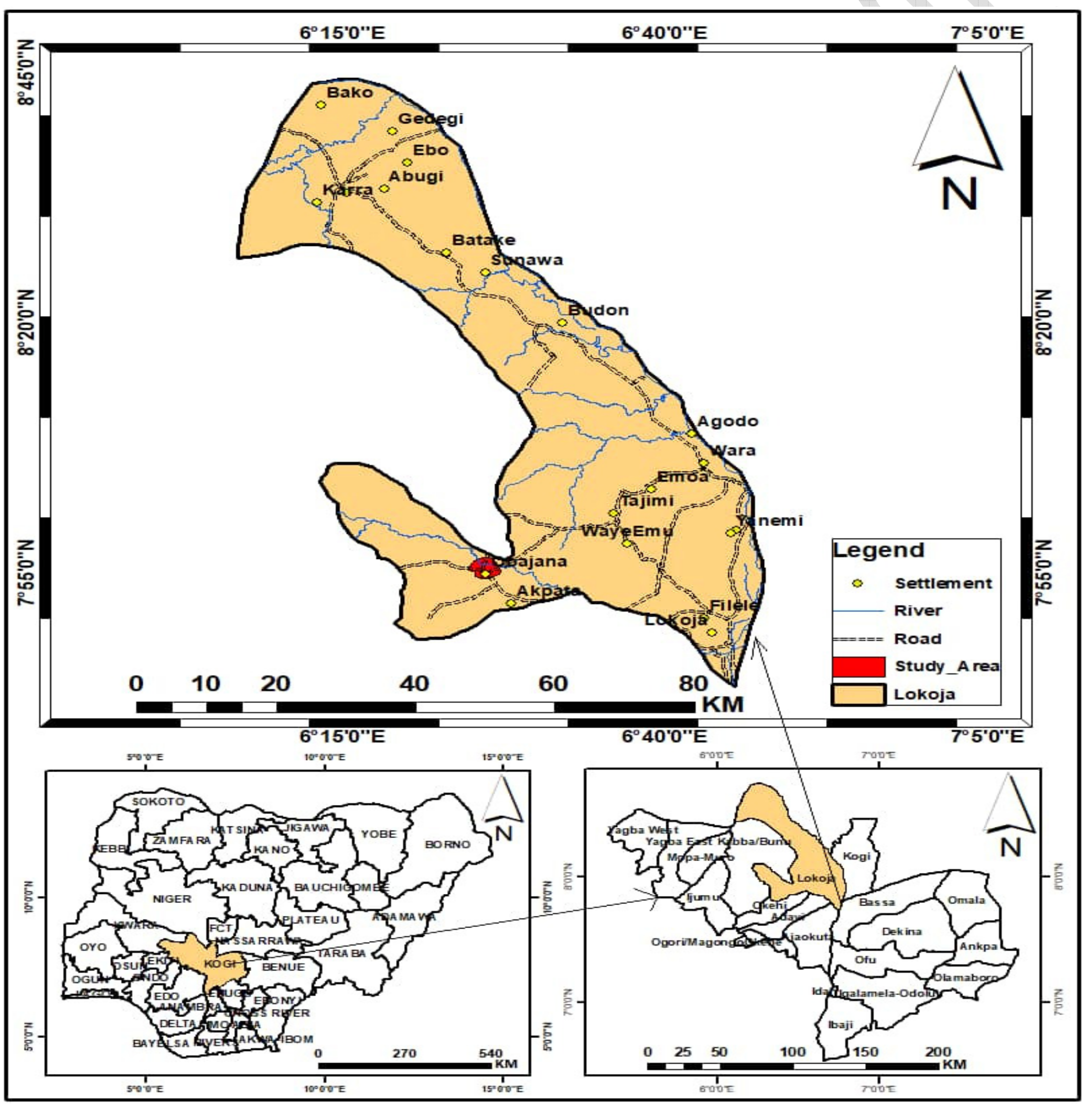

Figure 1: Map of the Study Area

Source: Adapted from the Administrative map of Kogi State (2018)

Materials and methods

The plant samples was collected directly from the field and taken to Soil Science laboratory at faculty of Agriculture, Ahmadu Bello University, Zaria, Kaduna state.

Sample collection

Plant sample collection

The type of sampling design that was adopted for sample collection is simple random sampling. Plant samples were collected in cultivated land at 0km from the factory. The random location was generated with a hand-held GPS and was divided into four radiant directions of east, south, west and north in clockwise manner (Gupta and Solanki, 2008; Ibanga, Umoh and Iren, 2008) and three locations was randomly selected at a grid sampling pattern for field sampling. At each sampling location, six sampling point was determined, the distance within each sampling point was 10m and the ear leafs of cassava and maize plant were collected and a total of 6 samples was collected.. Control plant samples were collected at a distance of about 7km from the cement factory where there is no record of cement dust pollution and 6 sample was also collected with the same procedure, making a total of 12 plant sample each to provide a representative sample of the whole study area (this is because the study area is homogenous). The plant samples were placed in a paper bag and properly labeled (paper bag is preferred to avoid decay or contamination of sample). 40 leafs each of cassava plant was collected per sample and 25 leafs of maize plant was collected per sample (this is the recommended sampling size for plant tissue analysis).

Laboratory analysis

Elemental Properties of Plant

Plant samples was decontaminated by washing and rinsing with deionised water, after which it was dried at temperature, not more than 70^{0}C then grinded and reduced to 0.5 -1.0mm particle size this is to ensure homogeneity.

Total Nitrogen (TN): The total nitrogen determination was done by macro Kjeldahl method as described by Bremner and Mulvaney, (1982). The optimum amount of nitrogen required by most plant is 1.5, < 1.5 (low), 1.5 (moderate), > 1.5 (high) and the range usually found in plant is 1%-5%.

Potassium (K) and Total phosphorous (P): Wet Digestion method was used as described by (George, Rolf and John, 2013). The optimum amount of potassium required by most plant is 1%. <1 (low), 1 (moderate) and >1 (high). Amount of phosphorus required by plant is 0.2% < 0.2 (low), 0.2 (moderate) and > 0.2 (high). The concentration of phosphorus usually found in plant is 0.1%- 0.5% and that of Potassium (K) is 0.5%-5%.T-test was employed in comparing the elemental composition of maize and cassava plant. The level of significance was tested at 0.05%

RESULT AND DISCUSSION

Elemental properties of maize crop at the polluted and control site were analysed and presented on Table 1

Table 1. Statistical comparism of elemental properties of maize crop in the dust polluted, control site and required amount

Elemental properties	Polluted	Control	t-value	P-value	optimum range
Nitrogen	0.21	1.01	-12.035	< 0.000	1.5
Phosphorus	0.15	0.23	-2.347	0.041	0.2
Potassium	2.21	1.51	-3.768	0.004	1

Source: Authors computation 2019

Nitrogen concentration

The mean concentration as seen on Table 1 of polluted site is 0.21 while the control is 1.01. This result showed that Nitrogen is higher in maize at the control than the polluted which implies that the concentration of nitrogen increases with increasing distance. The decrease in nitrogen concentration could be as a result of burning of plant residues during farming operations, leaching, and the high rate of organic-matter decomposition as well as continuous cropping, which promotes rapid mineralization and absorption of nitrogen (Donald, 2011). This agrees with Lamare and Singh, (2019) who carried out similar research at Jaintia Hills, Meghalaya

Phosphorus concentration

The mean concentration as indicated on Table 1 of polluted site is 0.15 while that of the control is 0.23. The concentration of phosphorus at the control is higher than the polluted showing an increase in content with increasing distance. Phosphorus is one of the vital components of cement and it is deposited along with cement dust. The availability of phosphorous in soil is heavily dependent upon the soil pH and its form present in the soil. Cement dusts contain calcium and when it comes in contact with phosphorus forms chelate resulting in reduction of phosphorus availability in the soils (Rawat and Katiyar, 2015).

Potassium concentration

The mean concentration as given on Table 1 of polluted site is 2.21 while that of the control is 1.51. The concentration at the polluted is higher than that of the control showing a decrease in concentration as distance increases. This increase could result from cement dust pollution. Similar finding reported that cement dust improved potassium content in soil and tend to remain higher than other cations (Oludoye and Ogunjebi, 2016) who carried out similar research at Larfage cement factory, Sagamu, Ogun state, Nigeria.

Elemental properties of cassava crop at the polluted and control site were analysed and presented on Table 2

Table 2 Statistical comparism of elemental properties of cassava crop in the dust polluted, control site and the require amount

Elemental properties	Polluted	Control	t-value	P-value	Required amount
Nitrogen	0.784	0.31	4.569	0.001	1.5
Phosphorus	0.38	0.36	0.240	0.815	0.2
Potassium	2.42	1.83	3.089	0.022	1

Source: Authors computation 2019

Nitrogen concentration

The mean concentration of nitrogen in cassava as seen on Table 2 at the polluted site is 0.784 and that of the control is 0.31. The concentration of nitrogen at the control site is higher than that of the polluted though the both record low concentration and below the amount required by in plant. The result also shows that there is significant difference between the polluted and the control site.

Phosphorus concentration

The mean concentration of phosphorus in cassava as given on Table 2 at the polluted site is 0.38 and the control is 0.36. The result shows that the concentration of phosphorus at the control is higher than the polluted site both result are higher than the amount required in plant. The result also shows that there is no significant difference between the polluted site and the control which implies cement dust does not affect the concentration of phosphorus.

Potassium concentration

The mean concentration of potassium in cassava as indicated on Table 2 at the polluted site is 2.42 while that of the control is 1.83 respectively. The polluted site has a higher mean value than the control. The result shows that the concentration of potassium at the polluted and the control site is high and there is also significant difference between the polluted and the control site

Conclusion

This study assessed the effects of cement dust pollution on cultivated crops in Obajana, Kogi state, Nigeria. Data was obtained from laboratory analysis of plant samples at Soil Science Laboratory, Faculty of Agriculure Ahmadu Bello University, Zaria, Kaduna state. Mean, standard deviation, coefficient of variability and T-test were used in analysing the data.

elemental properties in maize and cassava tested for were Nitrogen, Phosphorus and Potassium; in maize, nitrogen mean concentration at the polluted site was 0.21 and the control site 1.01, phosphorus mean concentration at the polluted site was 0.15 and at the control site 0.23, potassium mean concentration at the polluted site was 2.21 and at the control 1.51. In cassava, nitrogen had mean concentration of 0.784 at the polluted site and 0.31 at the control site, phosphorus had mean concentration of 0.38 at the polluted site and 0.36 at the control site, and potassium mean concentration at the polluted site was 2.42 and the control site 1.83 respectively.

The elemental properties of plants (maize and cassava) was also altered as a result of cement dust pollution; for maize plant, Nitrogen decreased with increasing distance away from the factory, phosphorus increased with increasing distance from the factory while potassium decreased with distance away from the factory. The result showed that there was no significant difference in elemental properties except for potassium which showed significant difference. In cassava plant nitrogen and phosphorus increased with increasing distance away from the factory and potassium decreased with increasing distance away from the factory and there was no significant difference for all the elemental composition in cassava plant.

The result also showed that the amount of potassium found in cassava plant was higher than that found in maize plant; this is because cassava is highly tolerant plant to acidicity or alkalinity of soil and because potassium acts on the synthesis and starch accumulation in the storage roots and as such taps more potassium from the soil than any other plant.

The elemental properties of maize and cassava plant was affected also although, there was no significant difference except for potassium in maize plant.

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